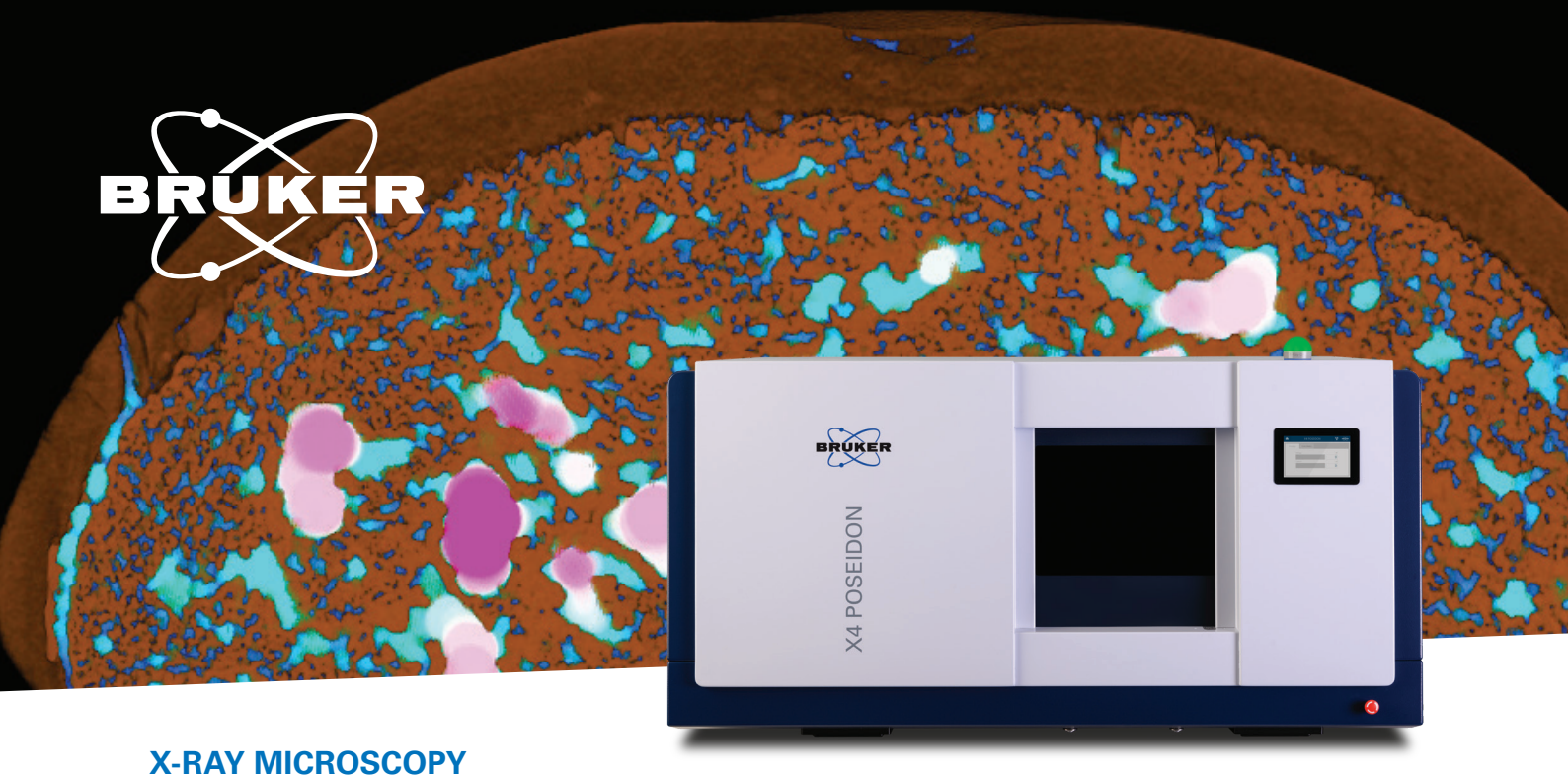

X-RAY MICROSCOPY

X4 POSEIDON – Chocolate “pepernoot” cookie

Application Report 7

Taste and texture perception in food products are a key factor for consumer acceptance. The food texture is tightly linked to its microstructure, which is influenced by product formulation and manufacturing processes. Therefore, characterizing the structural properties is crucial for developing new food products and processes or improving food formulas and quality. 3D X-Ray Microscopy (XRM) provides high-resolution, three-dimensional images that reveal intricate details of food microstructure, such as porosity, density, and spatial distribution of components. XRM is increasingly employed to non-destructively characterize foods ranging from baked goods to fruits, dairy, and meat products. It enables researchers and industry professionals to visualize and quantify structural changes caused by processes like baking, drying, freezing, and storage. Structural analysis provides deeper insights into the relationship between food structure and its functional properties, paving the way for innovations in food science and engineering.

As an example, this application note showcases the structural characterization of a chocolate covered “pepernoot” cookie, a traditional and popular sweet offer during the Sint Niklaas period in the Netherlands. Chocolate “pepernoots” are popular because of their rich flavor combining the sweetness of the chocolate with the spicy base of the “pepernoot” biscuit. XRM is the ideal technology for investigating the key structural properties that makes this popular sweet. With the new X4 POSEIDON it is now possible to get a fast and high-resolution detailed overview of these cookies in a versatile desktop XRM that can fit in most lab spaces.

The X4 POSEIDON microCT imaging workstation is a 3D imaging core facility on your desktop. The following settings were used for this study:

- 7 Mpixel Flat-panel X-ray camera
- 70 kV, 100 µA
- Scan duration: 9 min
- Voxel resolution: 11 µm

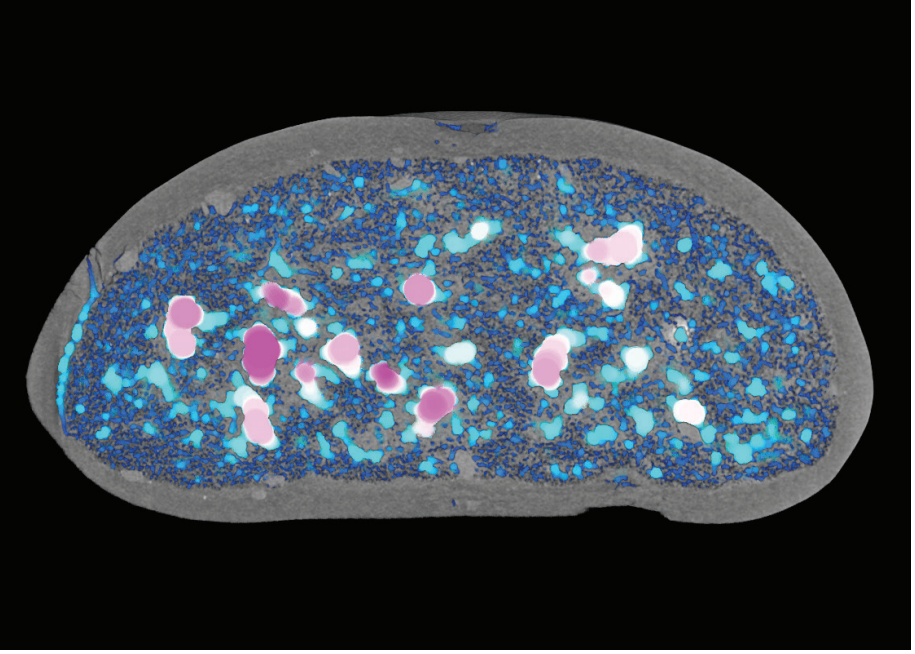

Figure 1
Orthogonal slice through the chocolate "pepernoot".

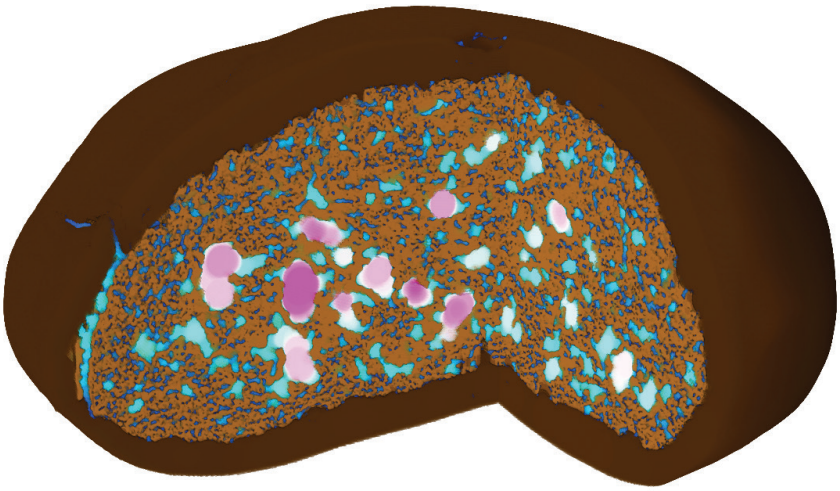

Figure 2
3D rendering with 3D analysis of the air pores size distribution from the "pepernoot" cookie.

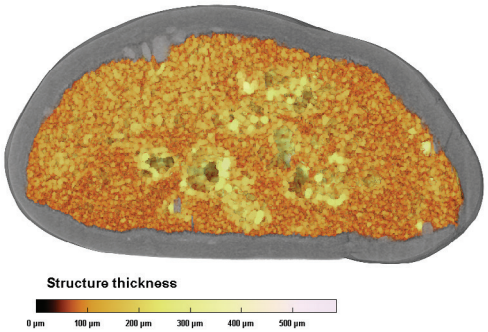

Figure 3
3D rendering with thickness analysis of the cookie crumb from the "pepernoot" cookie.

The orthogonal slice (Figure 1) through the sweet provides a clear view of its overall structure that highlights the chocolate enrobing the aerated structure of the cookie. The distribution of large and small air pores can be seen as well as the quality and continuity of the surrounding chocolate.

The baking process can be qualified through the analysis of the pore size. The volume rendering with a color-coded pore size thickness is illustrated in Figure 2. The change in color indicates the pore size thickness variation - purple highlights the largest pores and blue the smallest. Air pores with smaller sizes are distributed around the periphery of the cookie volume, becoming larger towards the center. No cracks or large air bubbles are detected which indicates a successful proofing and baking process. Some air cavities are present at the interface of the chocolate enrobing.

To understand the textural appreciation (crunchiness) of this sweet, a thickness analysis of the cookie crumb can be combined with the porosity analysis. The cookie thickness distribution is analyzed and color-coded in the Figure 3.

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